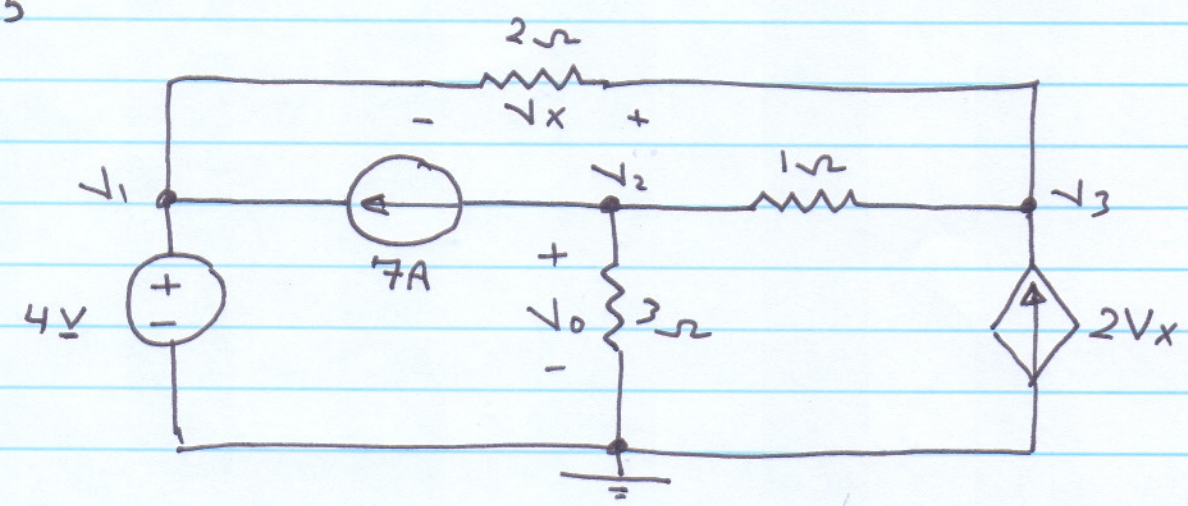
4.25



$V_1 = 4$ Constrain equation

$$-7 = \left(1+\frac{1}{3}\right)V_2 - V_3$$

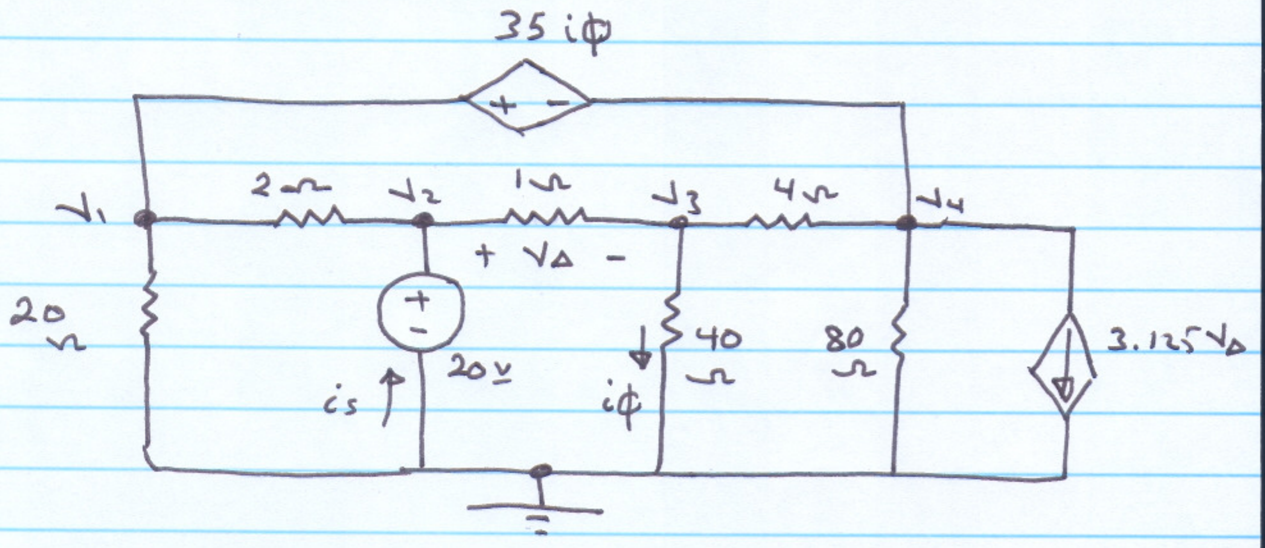
$$2V_x = -\frac{1}{2}V_1 - V_2 + \left(1+\frac{1}{2}\right)V_3$$

$$V_x = V_3 - V_1$$

Solving

$V_o = V_2 = 1.5\ \underline{V}$

4.28



$v_2 = 20$ Constrain equation

$v_1 - v_4 = 35 i_\phi$ Constrain equation

$$i_\phi = \frac{v_3}{40}$$

$$0 = -v_2 + \left(1 + \frac{1}{4} + \frac{1}{40}\right) v_3 - \frac{1}{4} v_4$$

$$-3.125 v_\Delta = \left(\frac{1}{2} + \frac{1}{20}\right) v_1 - \frac{1}{2} v_2 - \frac{1}{4} v_3 + \left(\frac{1}{4} + \frac{1}{80}\right) v_4$$

$$v_\Delta = v_2 - v_3$$

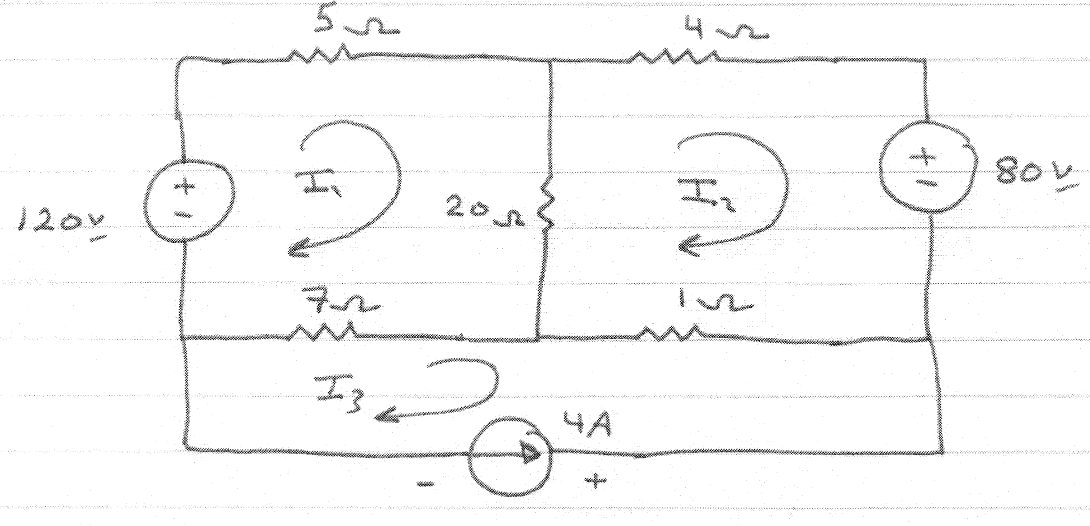
Solving :

$v_1 = -20.25\,\underline{v}$; $v_3 = 10\,\underline{v}$, and $v_4 = -29\,\underline{v}$

$$i_s = \frac{v_2 - v_1}{2} + \frac{v_2 - v_3}{1} = 30.125\ A$$

$P_{20\underline{v}} = 20 i_s = 602.5$ Watt Supply

4.42



$I_3 = -4A$ Constrain equation

$120 = 32 I_1 - 20 I_2 - 7 I_3$

$-80 = -20 I_1 + 25 I_2 - I_3$

Solving:

$I_1 = 1.55 A$, and $I_2 = -2.12 A$

$V_{4A} = 1(I_2 - I_3) + 7(I_1 - I_3) = 40.73 V$

$P_{4A} = 162.92 W$ (Supply)

$P_{120V} = (120)(I_1) = 186$ Watt Supply

$P_{80V} = (80)(I_2) = 169.6$ Watt Supply

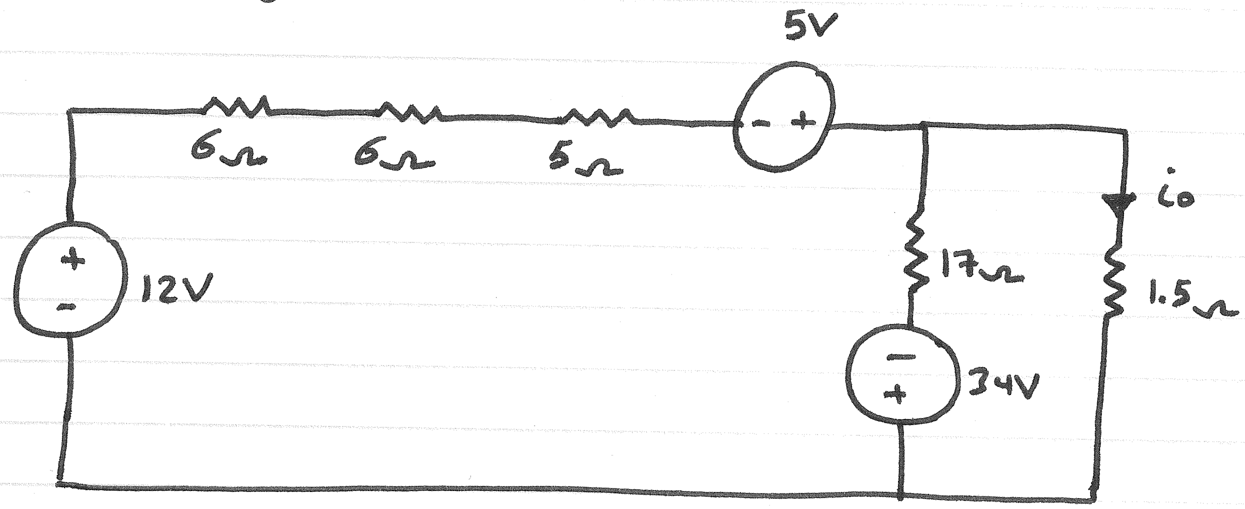
$\Sigma p_{supply} = 518.52$ Watt.

$\Sigma P_{resistances} = 5(1.55)^2 + 4(2.12)^2 + 20(3.67)^2 + 7(5.55)^2 + 1(1.88)^2$

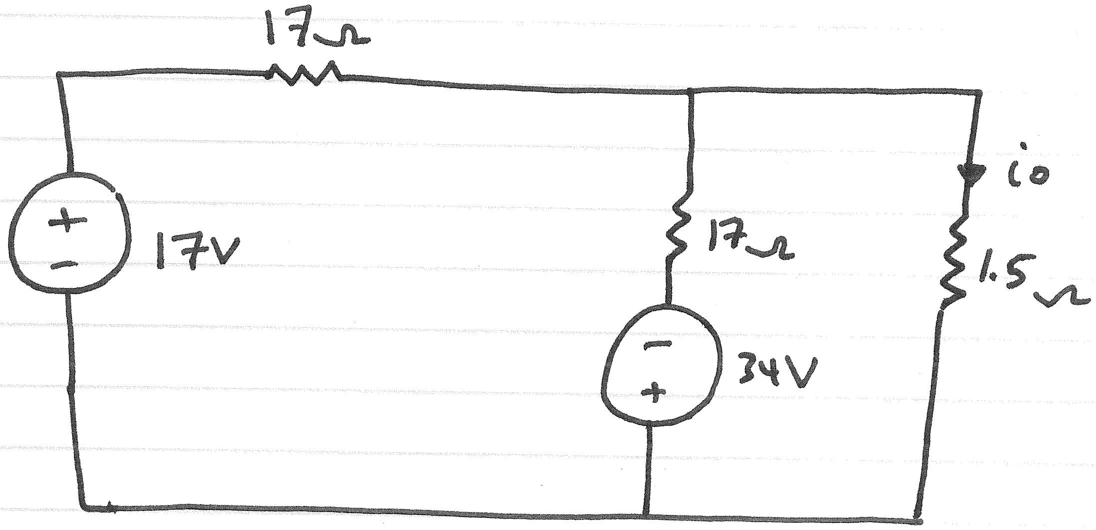
$= 518.52$ Watt (dissipated)

4.60

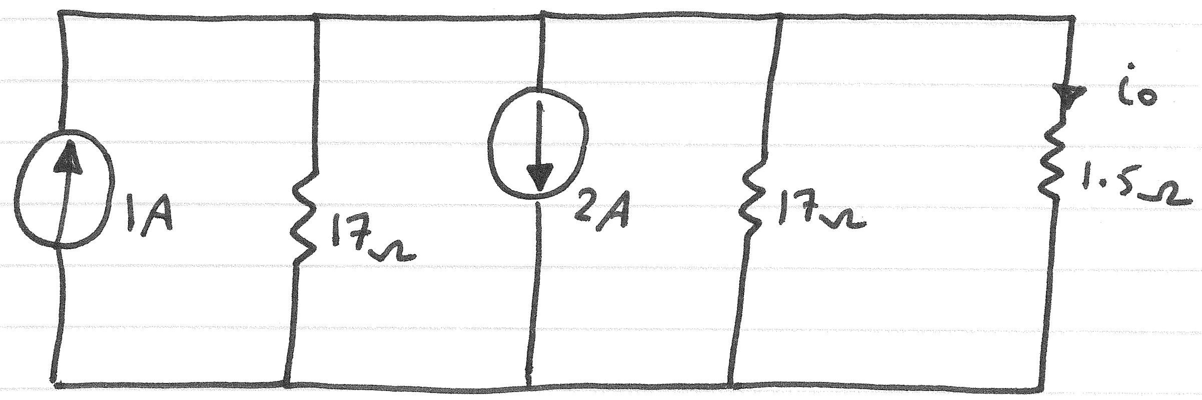
Applying source transformation to both current sources yields:



Combining the 12V and 5V into one source and adding the 3 resistors (6Ω, 6Ω, and 5Ω) in series

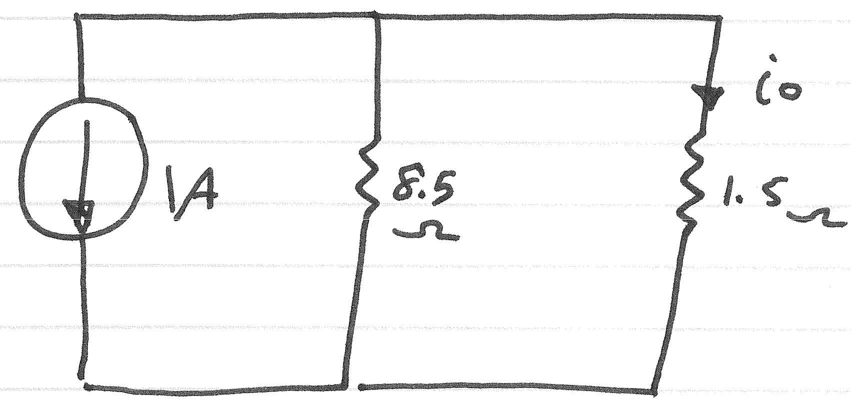


Now source transformation for both voltage sources



Combining 1A, 2A sources and the

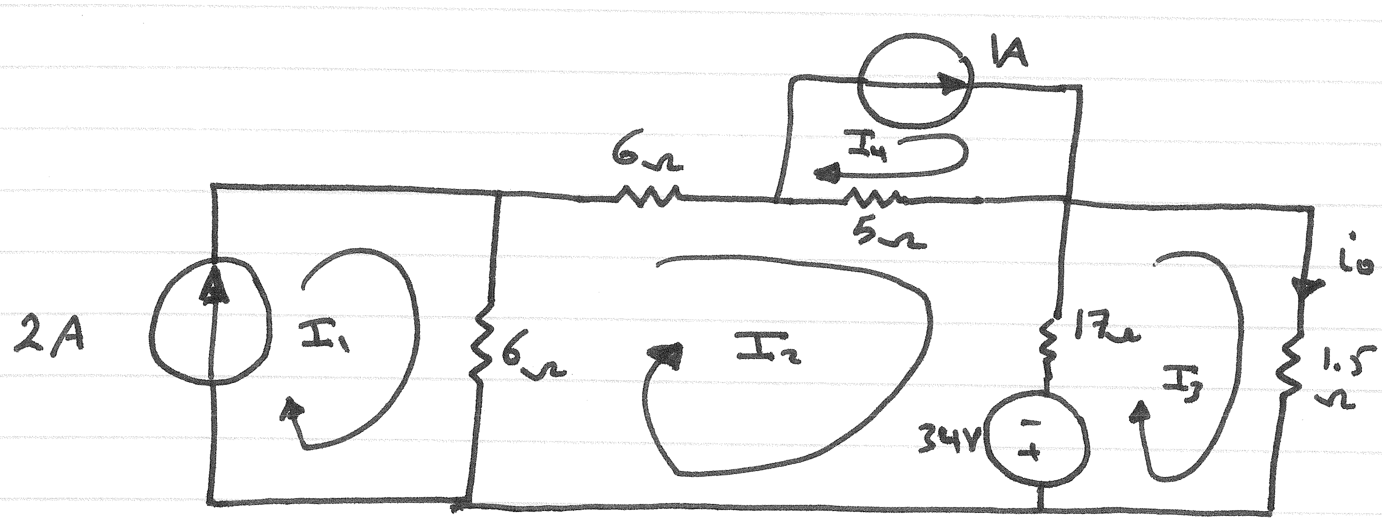
17Ω, 17Ω resistors



$$i_o = -\frac{8.5}{8.5+1.5} \, 1A$$

$$i_o = -0.85\,A$$

b) Verification by mesh - Current method.



$I_1 = 2A$ Constrain equation

$I_4 = 1A$ Constrain equation

mesh 2 KVL :

$34 = -6I_1 + 34I_2 - 17I_3 - 5I_4$

mesh 3 KVL :

$-34 = -17I_2 + 18.5I_3$

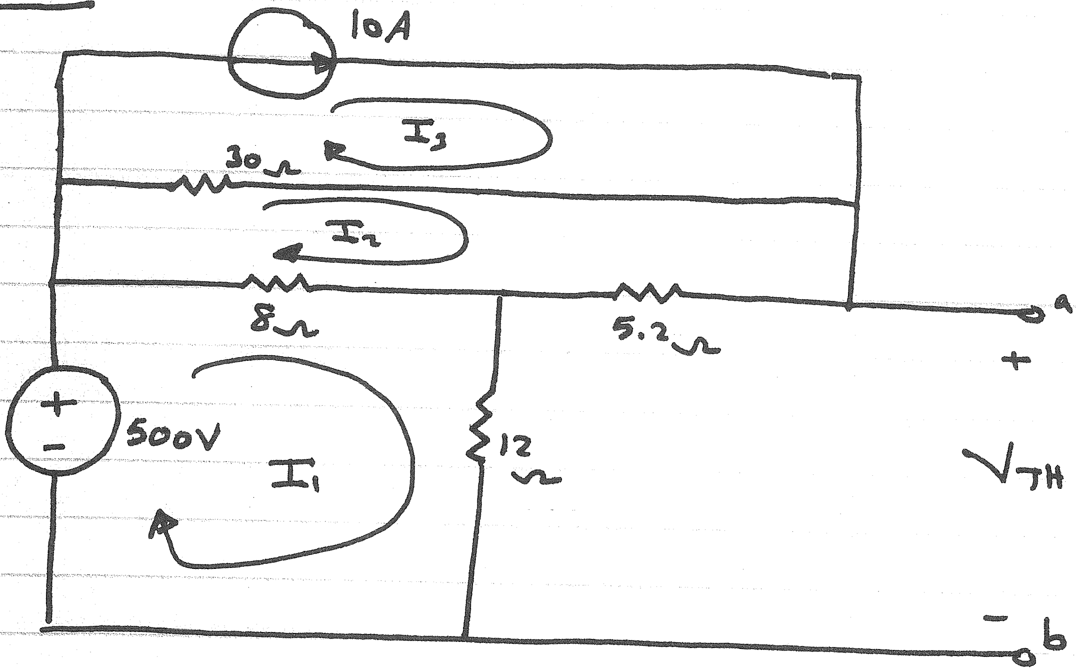
Solving for I_2 and I_3 yields :

$I_3 = -0.85 A$

$I_2 = 1.075 A$

$\therefore i_o = I_3 = -0.85 A$

4.66



$$V_{TH} = (5.2\,\Omega)\,I_2 + (12\,\Omega)\,I_1$$

$I_3 = 10\,A$ Constrain equation

KVL for mesh 1 :

$$500 = 20\,I_1 - 8\,I_2$$

KVL for mesh 2 :

$$0 = 43.2\,I_2 - 30\,I_3 - 8\,I_1$$

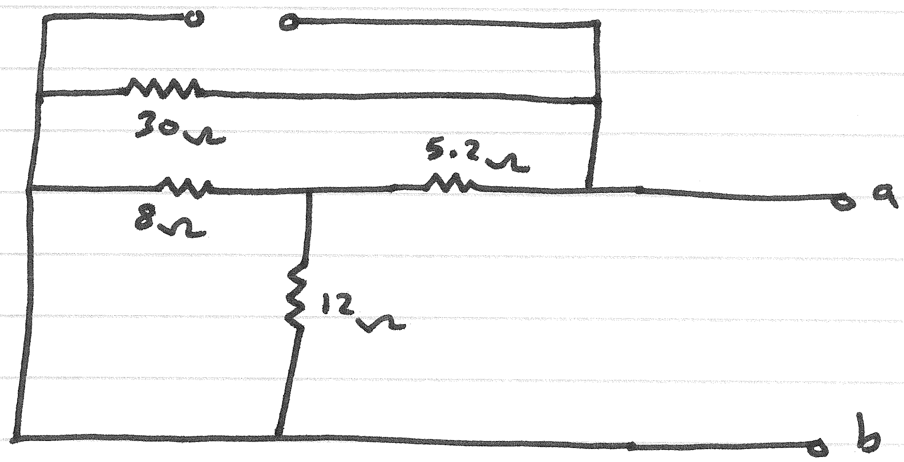
Solving for I_1 and I_2 yields :

$$I_1 = 30\,A$$

$$I_2 = 12.5\,A$$

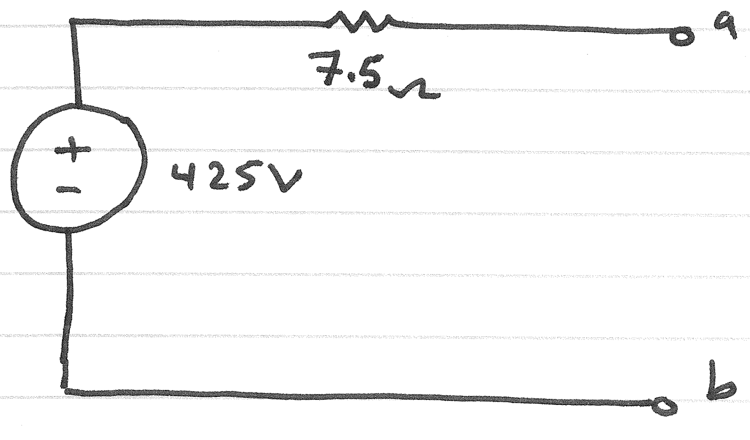
$$\therefore\ V_{TH} = (5.2)(12.5) + (12)(30) = 425\,V$$

To find R_{TH}, set all the independent sources to zero.

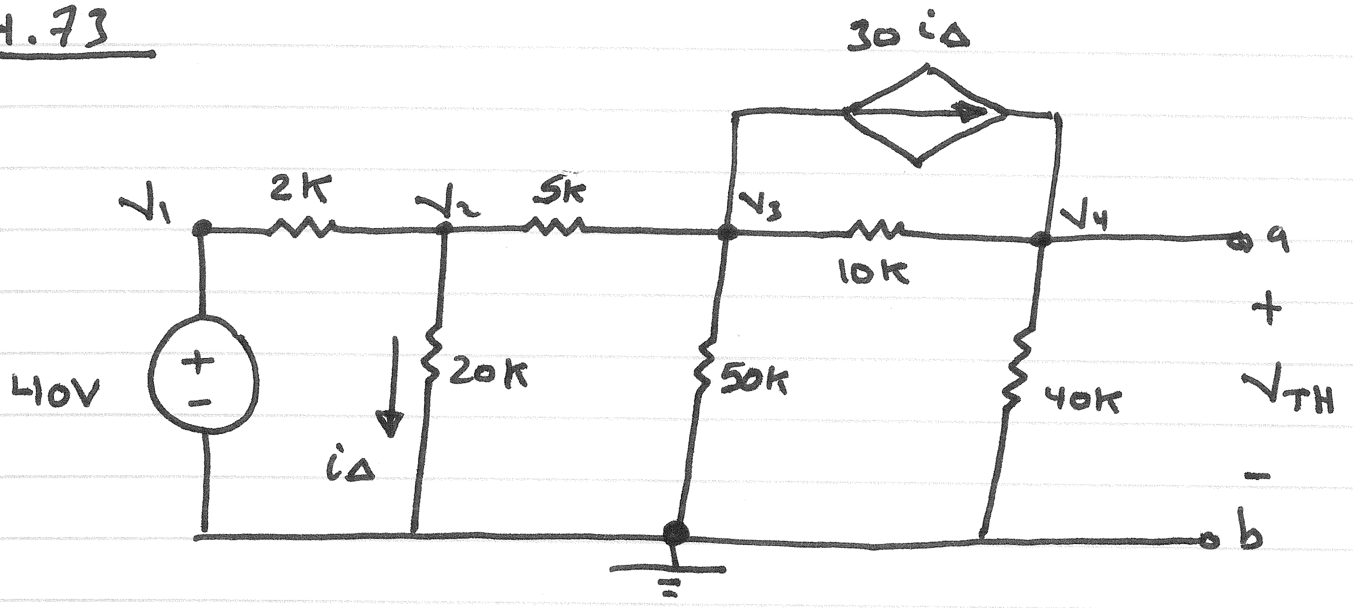


$$R_{TH} = 30\Omega \parallel \left(5.2\Omega + 8\Omega \parallel 12\Omega \right)$$

$$R_{TH} = 7.5\Omega$$



4.73



$V_{TH} = V_4$

KCL at node 2 :

$$\left(\frac{1}{2K} + \frac{1}{20K} + \frac{1}{5K}\right)V_2 - \frac{1}{2K}V_1 - \frac{1}{5K}V_3 = 0$$

KCL at node 3 ,

$$-30\,i_\Delta = -\frac{1}{5K}V_2 + \left(\frac{1}{5K} + \frac{1}{50K} + \frac{1}{10K}\right)V_3 - \frac{1}{10K}V_4$$

$$i_\Delta = \frac{V_2}{20K}$$

KCL at node 4 :

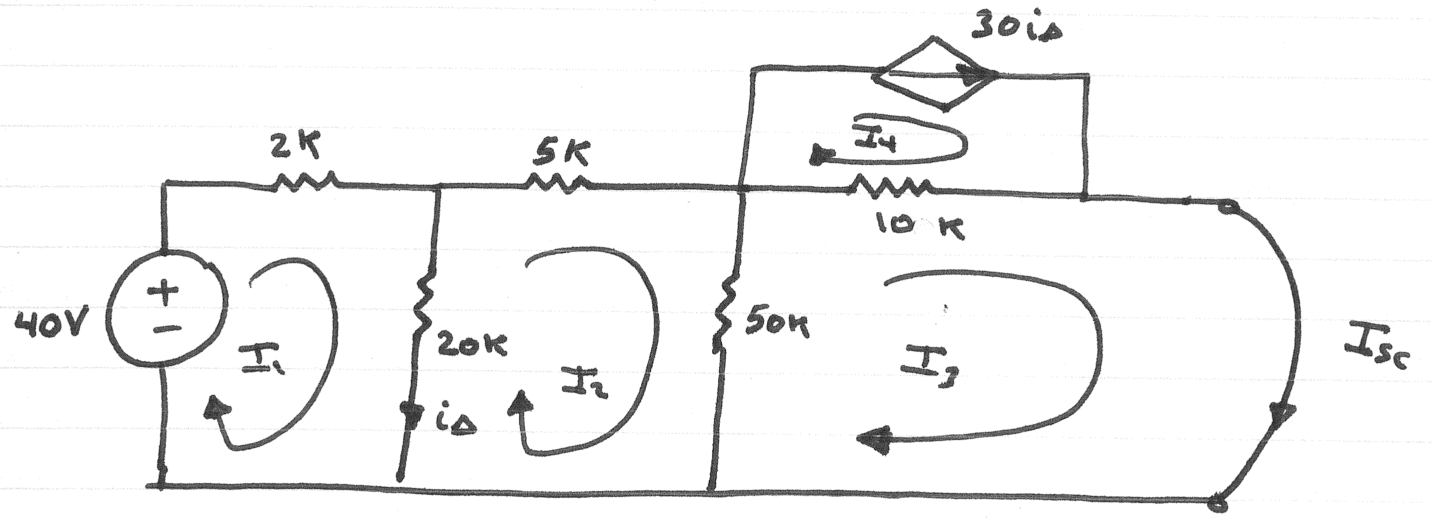
$$30\,i_\Delta = -\frac{1}{10K}V_3 + \left(\frac{1}{10K} + \frac{1}{40K}\right)V_4$$

$V_1 = 40V$ constrain equation

Solving for V_4

$V_4 = 280V$, $\therefore V_{TH} = 280V$

To find $R_{TH} = \frac{V_{TH}}{I_N}$



$I_{sc} = I_N = I_3$

KVL for mesh 1 :

$$40 = 22K\, I_1 - 20K\, I_2$$

KVL for mesh 2 ,

$$0 = -20K\, I_1 + 75K\, I_2 - 50K\, I_3$$

KVL for mesh 3 :

$$0 = -50K\, I_2 + 60K\, I_3 - 10K\, I_4$$

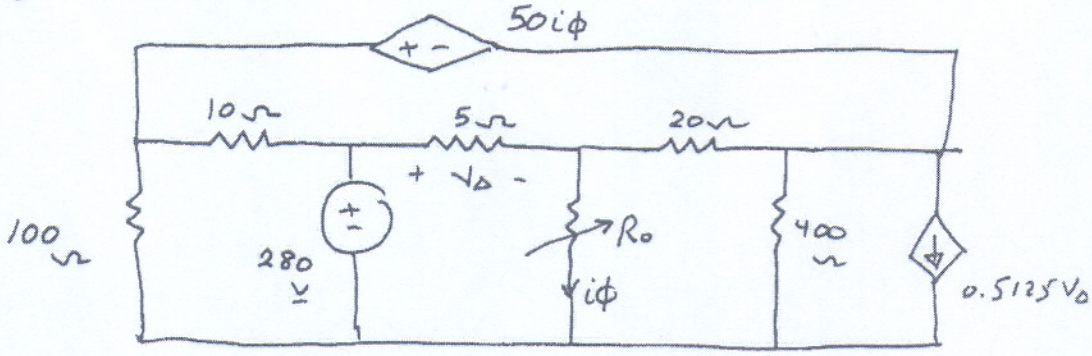
$I_4 = 30\, i_\Delta$ Constrain equation

$i_\Delta = I_1 - I_2$

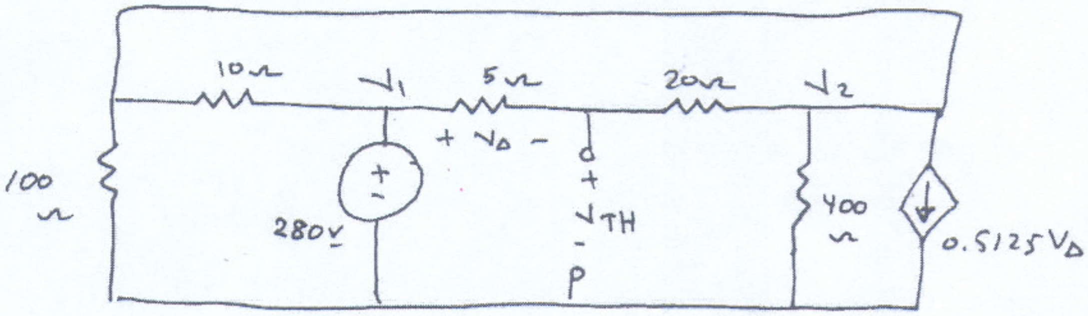
Solving for $I_3 = I_{sc} = I_N = 14\,mA$

$\therefore R_{TH} = \frac{V_{TH}}{I_N} = 20K\Omega$

4.88



1) To find V_{TH} ; $i\phi = 0 \longrightarrow 50 i\phi = 0 \longrightarrow$ Short Circuit



Supernode

$$V_2\left(\frac{1}{100}+\frac{1}{10}+\frac{1}{400}+\frac{1}{25}\right)-\left(\frac{1}{10}+\frac{1}{25}\right)V_1 = -0.5125\,V_\Delta$$

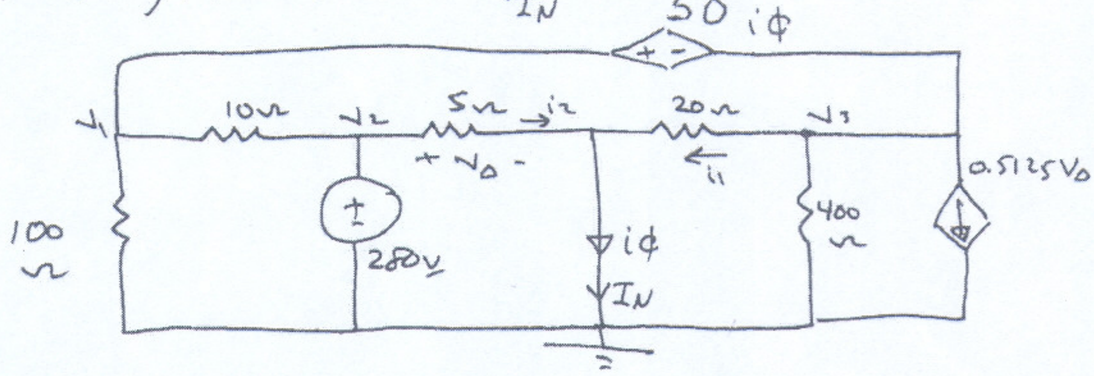
$V_1 = 280$ Constrain equation

$$V_\Delta = \frac{5}{5+20}\left(V_1 - V_2\right)$$

$\therefore V_2 = 210\text{ V}$; $V_\Delta = \frac{5}{25}\left(280-210\right) = 14\text{ V}$

$V_{TH} = -V_\Delta + 280 = 266\text{ V}$

2) To find $R_{TH} = \frac{V_{TH}}{I_N}$



$V_1 - V_3 = 50\, i\phi = 50 I_N$

$V_2 = 280\,V$

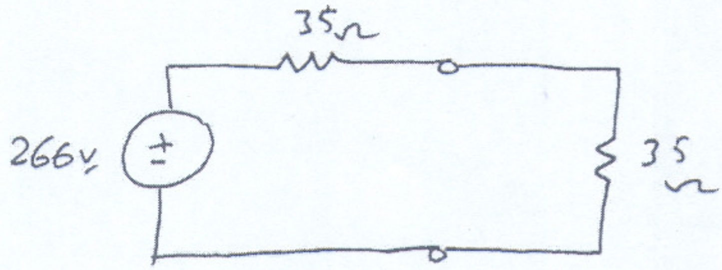
Supernode equation

$$V_3\left(\frac{1}{400} + \frac{1}{20}\right) + V_1\left(\frac{1}{100} + \frac{1}{10}\right) - \frac{1}{10} V_2 = -0.5125 V_0$$

$V_0 = 280\,V$; $V_3 = -968\,V$

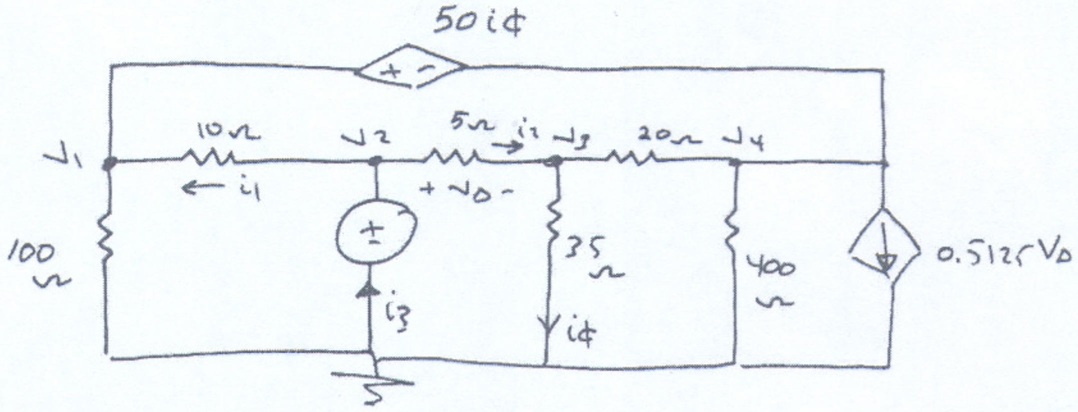
$$I_N = i_1 + i_2 = \frac{-968}{20} + \frac{280}{5} = 7.6\,A$$

$$\therefore R_{TH} = \frac{266}{7.6} = 35\,\Omega$$



$$P_{max} = \frac{V_{TH}^2}{4 R_{TH}} = 505.4\,W$$

c)



$v_1 - v_4 = 50 i_\phi$; $i_\phi = \frac{v_3}{35}$

$v_2 = 280\,\underline{V}$

$v_3\left(\frac{1}{5} + \frac{1}{35} + \frac{1}{20}\right) - \frac{1}{5}v_2 - \frac{1}{20}v_4 = 0$

Supernode

$v_1\left(\frac{1}{10} + \frac{1}{100}\right) + v_4\left(\frac{1}{400} + \frac{1}{20}\right) - \frac{1}{10}v_2 - \frac{1}{20}v_3 = -0.5125\,V_o$

$v_o = v_2 - v_3$; $v_3 = 133\,\underline{V}$

$\therefore v_1 = -189\,\underline{V}$

$i_1 = \frac{280+189}{10} = 46.9\,A$

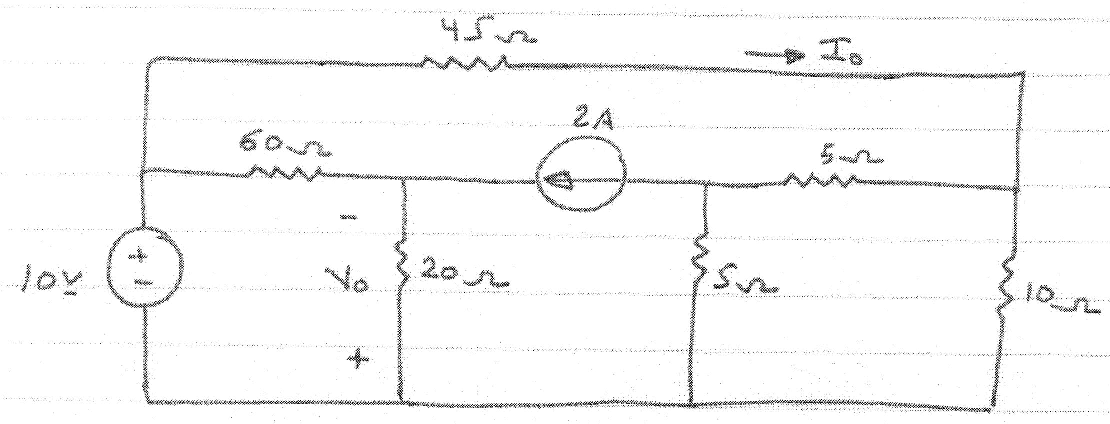
$i_2 = \frac{280-133}{5} = 29.4\,A$

$i_g = i_3 = i_1 + i_2 = 76.3\,A$

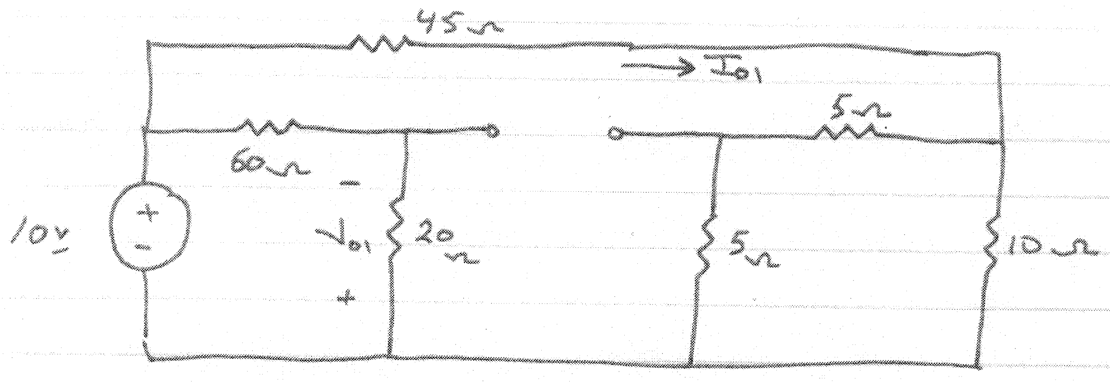
$P_{v_s} = (76.3)(280) = 21364\,W$

supply

4.92



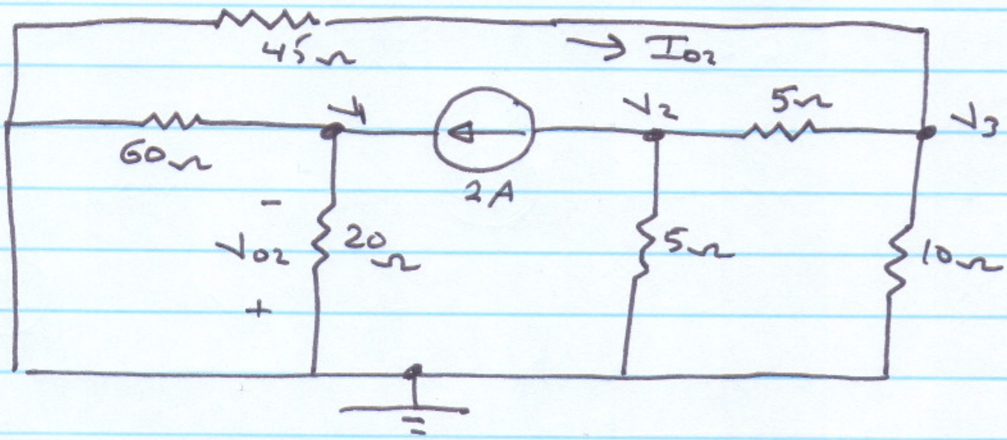
1) let V_s on, I_s off (open circuit)



$$I_{01} = \frac{10}{45 + 10 \| (5+5)} = 0.2\,A$$

$$V_{01} = \frac{20}{20+60}(-10) = -2.5\,V$$

2) let I_s on, V_s OFF (short circuit)



$$2 = \left(\frac{1}{20} + \frac{1}{60}\right) V_1 -$$

$$-2 = \left(\frac{1}{5} + \frac{1}{5}\right) V_2 - \frac{1}{5} V_3$$

$$0 = -\frac{1}{5} V_2 + \left(\frac{1}{5} + \frac{1}{10} + \frac{1}{45}\right) V_3$$

Solving :

$V_2 = -7.25$, $V_3 = -4.5 \text{ v}$, and $V_1 = 30 \text{ v}$

$$V_{o2} = -V_1 = -30 \text{ v}$$

$$I_{o2} = -\frac{V_3}{45} = 0.1 \text{ A}$$

$$\therefore \quad I_o = I_{o1} + I_{o2} = 0.3 \text{ A}$$

$$V_o = V_{o1} + V_{o2} = -32.5$$